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SYLLABUS

Of a COURSE of

LECTURES

On the most Interesting PARTS of

MECHANICS,		PNEUMATICS,
HYDROSTATICS,		ELECTRICITY, and
HYDRAULICS,		ASTRONOMY.

By JAMES FERGUSON, F. R. S.

Philosophia Mater omnium bonarum Artium est.

CICERO 1 Tusc.



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SYLLABUS

LECTURES

OF THE HISTORY OF
THE
HYDRAULIC ENGINE
AND
THE
HYDRAULIC PRESS



LONDON

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P R E F A C E.

***T**O shew how the natural Strength may be assisted by Art, and how to construct Machines of sufficient Powers for that Purpose; — to compute the Power of any Machine or Engine already constructed, and point out its Perfections or Defects; — to explain the wonderful Properties of Water and Air, and prove them by the most plain and obvious Experiments; — to shew the Methods by which Water may be raised to any given Height, for Gentlemen's Seats, &c. and what Degree of Power is requisite for that Purpose; — to investigate the Laws by which the *ALMIGHTY* regulates and governs all the Celestial Motions around us, and to account for the general Appearances depending on these Laws and Motions; — to demonstrate the Truth of a general Providence, and of some very remarkable Parts of Scripture; — and, in short, to make Mankind so much the wiser and better, as to promote both their temporal and eternal Happiness, are Subjects of too interesting a Nature to need any Recommendation.*

For these Purposes the following Course is chiefly intended; which is a full Answer to a very common Question, namely, What is the Use of Philosophy?

P R E F A C E

To the Reader

I have the honor to acknowledge the receipt of your letter of the 10th inst.

in relation to the matter of the

and in reply to inform you that the same has been forwarded to the proper authorities for their consideration.

I am, Sir, very respectfully,
Your obedient servant,

J. H. [Signature]

18 [Date]

[Address]

[City]

[State]

[Country]

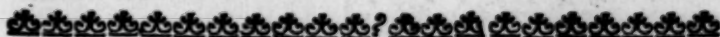
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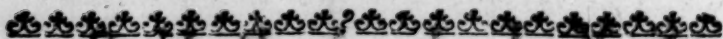
LECTURE I

On the Mechanical Powers.

 PLAIN and easy Method of computing the Power or Advantage gained by all Sorts of Machines and Engines, be they ever so simple or complex. — This Method applied,

1. To the Lever.
2. To the Wheel and Axle.
3. To the Pullies.
4. To the Inclined Plane.
5. To the Wedge.
6. To the Screw.
7. To a compound Engine, in which all these six simple Machines are included.
8. To a Model of the fine Crane at Bristol.
9. To a new Crane with four different Powers for different Weights, invented by Mr. Ferguson.

A new Pyrometer shewn and explained, that makes the Expansion of Metals by Heat visible to the ninety-thousandth Part of an Inch.



LECTURE II.

On Mills, Wheel-Carriages, &c.

The Centre of Gravity, and Line of Direction, explained.

A double Cone shewn, that seems to ascend whilst it is actually descending.

A Machine for diminishing Friction, shewn.

The Utility of Broad-Wheels in Land-Carriages demonstrated to exceed that of Narrow-Wheels.

The Absurdity of the common Method of loading the Waggon, proved by Experiment; and a better Method pointed out.

That Carriages with large Wheels are more easily drawn than with small Wheels, proved.

A Method of finding what degree of Power is requisite for drawing a loaded Waggon or Cart up Hill, when the Slope of the Hill, and the Weight of the Carriage and Load, are known.

A curious Model of a Reading Desk, shewn.

A most curious Silk Reel (invented by Mr. Verrier of *Somersetshire*), shewn.

The Structure of Water-Mills, Hand-Mills, and Sawing-Mills, explained by Means of Working Models.

A Method for constructing Water-Mills in the most perfect Manner, shewn.

The Method of driving the Piles at *Westminster* Bridge explained by Means of a Working Model of the Engine used for that Purpose.

A

A Proof, that the Force of the Wind on Wind-mill Sails is as the Square of the Velocity of the Wind.



LECTURE III.

On Hydrostatics.

That Fluids weigh as much in their own Elements as they do in Air, proved.

That the Pressure of Fluids is in Proportion to their perpendicular Heights, without any Regard to their Quantities, proved.

That Fluids press equally in all Manner of Directions, proved,

That, from this Pressure, solid Lead may be made to swim in Water, and light Wood to lie at the Bottom of a Vessel filled with Water.

That an Ounce of Water in a Tube will raise and support more than sixteen Pound Weight of Lead.

The Hydrostatical Paradox shewn and explained.

That the Quantity of Water displaced by a Ship is equal to the Weight of the Ship, and all that is in it, proved.

The Working of Syphons shewn and explained. And thence,

The *Tantalus's* Cup. — The intermitting Fountain, shewing the Cause of the periodical Running and Stopping of some Springs, and of the ebbing and flowing of Wells.

Reciprocating Springs explained, and shewn by a Machine.

LECTURE IV.

Bodies, and Hydraulic Engines.

When a solid Body is immersed and suspended in a fluid, it loses as much of its Weight as its Bulk of the Fluid weighs; and that the Weight lost by the Solid is imparted to the Fluid. — Hence,

The Method of finding the Specific Gravities of Bodies, or their comparative Weights, Bulk for Bulk; and thereby to discover whether any suspected Piece of Gold, or other Metal, be genuine or counterfeit.

A working Model of ARCHIMEDES'S spiral Pump shewn and explained.

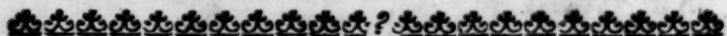
The Operations of the common sucking, forcing, and lifting Pumps, explained, and shewn by Glass Models.

A working Model of a Quadruple forcing Pump Mill, for raising Water to any given Height, shewn and explained.

A working Model of the *Persian Wheel* shewn.

A working Model of the great Engine at *London Bridge*, and of the Engine that raises Water from the *Hungarian Mines*, shewn and explained.

A working Model of a new Fire-Engine, shewn and explained.



LECTURE V.

On the Air Pump. — The Weight of the Air.

The Nature and Properties of the Air described.

The Mechanism of the Air-Pump explained.

An Experiment, shewing, that no Air can pass from the lateral into the longitudinal Pores of Wood.

That,

That, without Air, there could be no Sound, shewn by a Bell, that will not ring in a Glass out of which the Air is exhausted.

That Air resists the Motion of Bodies, is shewn,

By the unequal Velocities of a Guinea and the Down of a Feather falling in Air, and their falling equally quick in a Glass exhausted of Air.

That the Air has Weight, is shewn,

1. By weighing a known quantity of it in Scales; and thereby to know the Weight of any other Quantity thereof.
2. By its pressing down the Hand on an open Glass, when the Air is exhausted out of the Glass.
3. By its breaking a Bladder on an exhausted Glass.
4. By its forcing Quicksilver through the Pores of Wood.
5. By the *Toricellian* Experiment, shewing the Nature and Operations of the common Barometer.
6. By the Operation of the common Pump; in which it is proved, that the Pump raises Water by Means of the Pressure of the Air, and not by Suction.
7. By its Effect on two Glasses; in which it is proved, to a Demonstration, that the Glasses are held down on the Air-Pump by the Pressure of the Air, and not by any such Thing as Suction of the Pump.
8. By its forcing Water into a hollow Ball of Glass exhausted of Air.
9. By an artificial Fountain—And,
10. By the great Force required to separate two hollow Hemispheres of Brass when the Air is exhausted out of them.

LECTURE VI.

On the Air-Pump. — The Spring of the Air.

An Experiment to prove that the Air presses upward. — to prove that Bodies loose part of their Weight in Air.

— to prove that Flame and Smoke do not ascend in Air on account of positive Levity, but because they are lighter than Air.

— to shew by what Means Fishes can raise themselves to the Surface of the Water, or let themselves down to the Bottom.

The Spring of the Air shewn,

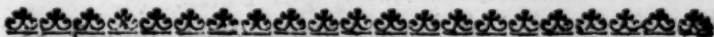
1. By a Bladder that appears almost empty in common Air, but seems full blown in an exhausted Glass.
2. By about ten Grains of Air, which expands so strongly when the outward Pressure is taken off, as to raise and support 16 Pound Weight of Lead.
3. By forcing the Water out of a hollow Ball of Glass.
4. By three artificial Fountains.
5. By transferring Air out of one Vessel into another.
6. By the Bubbles in warm Water or Beer, which makes Beer seem to boil when the Pressure of the Air is removed. — Also by the amazing Quantity of Air in a small Piece of Wood.
7. A Demonstration, that the Spring of the Air is equal to the Pressure thereof.
8. Some Effects of burnt Air shewn. — The Distempers common in Jails, and in the Holds of Ships, and the Effects of the Air in the *Grotto del Cani* at Naples, accounted for.

L E C.

LECTURE VII.

On Electricity.

The general Laws of Electricity explained; and confirmed by a great Variety of curious and entertaining Experiments, shewn by taking of Sparks, giving gentle Shocks, turning little Mills with Paper-Vanes, striking Holes through Cards, electrifying *plus* and *minus*, ringing of Bells, causing Cork-Balls with Linen Threads for Legs to move like Spiders. The Method of giving a Shock to any Part of the Body without affecting any other Part, and of preserving Buildings from being damaged by Lightning, shewn.



LECTURE VIII.

On Matter, and the Laws of Motion. — These Laws applied to the Motions of the celestial Bodies, and confirmed by Experiments on the Whirling Table, &c.

That Matter, being entirely inactive, can neither begin to move of itself, nor stop after it has been put into Motion in a free and unresisting Space.

The Reason why any Body, put into Motion, on or near the Earth, gradually loses its Velocity, and soon comes to a State of Rest.

That when Matter is put into Motion by any single Impulse, in free Space, it would for ever go on in the Direction of that Impulse, and with an undiminished Velocity.

That when two Forces act upon Matter, in different Directions, it cannot go on in the Direction
of

of either of these Forces, but in a different Direction arising from both of them.

That when Matter moves in a Curve, of any Kind whatever, it must be acted upon by two Forces at least.

That all Bodies moving in circular or elliptical Orbits, have a constant Tendency to fly off from these Orbits, and to move in rectilineal Courses. And,

That therefore, when a Body moves in an Orbit, there must be a constant Force either drawing or impelling it towards the Centre of that Orbit.

That the Force which draws or impells a Body toward the Centre of the Orbit in which it moves, is called the *centripetal Force*; and that by which it has a constant Tendency to fly off from its Orbit, is called the *centrifugal Force*.

The Proportion of these Forces, with respect to each other, for retaining a Body moving in a circular Orbit, shewn,

That the Force by which a Body is moved forward in its Orbit, is called the *projectile* or *tangential Force*; and that the Force by which the Body is attracted or impelled towards the Centre of its Orbit, is called the *gravitating Force*; or, in general, *the Power of Gravity*.

That the Planets are moved in their Orbits by a *projectile Force* impressed upon them at the Beginning; and that they are retained in their Orbits by *the Power of Gravity*, which is constituted by the Force of the *Sun's Attraction*,

That, if the Velocities of Planets in their Orbits were *doubled*, it would require a *quadruple* Power of Gravity to retain them in their Orbits.

That when one Body moves round another in free Space, both these Bodies must move round the common Centre of Gravity between them.

That

That the Earth and Moon move round the common Centre of Gravity between them, every Month; on which Account the Earth is always nearer the Sun at the Time of Full Moon, than at the Time of New Moon.— The Quantity of this Approach towards the Sun, and Recess from the Sun, shewn.

A Demonstration of the grand Law by which all the Planets move round the Sun, and are retained in their Orbits; by which it is proved, that the Earth moves round the Sun, in common with the rest of the Planets; and that the Power of Gravity (or Solar Attraction) diminishes in Proportion as the Square of the Distance from the Sun increases.

A Demonstration of the Earth's Motion round its Axis.

The Phenomena of the Tides shewn by a particular Machine; and the Cause of their rising equally high at the same Time, on opposite Sides of the Earth, made evident to Sight.



LECTURE IX.

On Astronomy, shewing the Phenomena arising from the Motions of the celestial Bodies in the SOLAR SYSTEM, by Means of the ORRERY and COMETARIUM.

An introductory Discourse on the Use of Astronomy; and the great Benefits arising from the Knowledge thereof, with regard both to our religious and civil Concerns.

An Account of the Bulks of the Sun and Planets; and the Distances of the Planets from the Sun, as found by the Transit of *Venus* over the Sun on the 6th of June, A. D. 1761.

The

The annual and diurnal Motions of the Planets
shewn by the ORRERY, and the Motions of
the Comets by the COMETARIUM.



LECTURE X.

On Astronomy.—The ORRERY.

The Reason why the rest of the Planets, seen from
our own Planet the Earth, appear sometimes to
go backward, sometimes forward, and some-
times to have no Motion at all.

The different Lengths of Days and Nights, and
the Vicissitudes of the Seasons, shewn.

The amazing Swiftneſs of Light demonſtrated.

The Method of finding the Longitude by the
Eclipses of *Jupiter's* Satellites, explained.



LECTURE XI.

On Astronomy.—The ORRERY.

The Motions and Phases of the Moon, and the
Length of her Days and Nights, shewn.

The extraordinary Benefit of Moon-Light to those
who live near the Pole of the Earth, shewn.

The Harvest-Moon plainly accounted for.

The Appearances of the Earth, as seen from the
Moon, described.

LECTURE XII.

On Eclipses, and the Darknes at the Time of our SAVIOUR's Crucifixion, &c.

The Earth proved to be much less than the Sun,
and bigger than the Moon.

The Causes of Solar and Lunar Eclipses shewn;
and the Reason why we have so many New and
Full Moons, and so few Eclipses.

The Number, Periods, and Restitution of Eclipses,
shewn.

All the Variety of Eclipses represented, as they
happen in Nature.

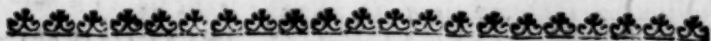
The different Seasons shewn by a Lamp, enlighten-
ing a Terrestrial Globe in Motion.

The Eclipses of *Jupiter's* Satellites, and the Phe-
nomena of *Saturn's* Ring, shewn.

The Darknes at the Time of our SAVIOUR's
Crucifixion proved to have been supernatural.

A remarkable Prophecy in the Book of *Daniel*,
concerning the Year of our SAVIOUR's Cru-
cifixion, explained.

The Year thereof truly ascertained from Astrono-
mical Principles, and found to agree with the
above-mentioned Prophecy, *Dan.* Chap. ix.
from Ver. 24. to the End.



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